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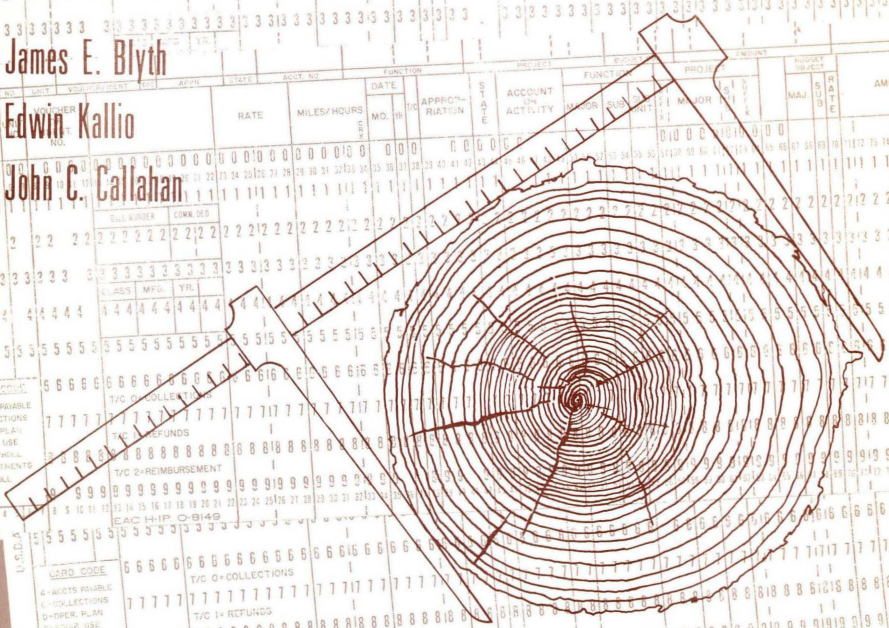

NORTH CENTRAL FOREST EXPERIMENT STATION
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Standing Timber Coefficients for Indiana Walnut Log Production

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The problem of effectively utilizing walnut timber has been magnified in recent years because of the rapidly increasing demand for this valuable species. Reliable converting factors related to current logging practices are needed to provide more accurate estimates of the volume of walnut timber cut. These statistics are needed to provide a better appraisal of the walnut resource, especially in comparing the timber cut with growth. Up-to-date information on the kinds and amounts of logging residue may provide the basis for better utilization, which would extend the available walnut resource. Information about the amount of walnut harvested from nongrowing-stock sources will also improve estimates of the total drain.

During 1966 a study was made by the U.S.D.A. Forest Service in cooperation with Purdue University to develop factors for converting the volume of rough walnut saw logs and veneer logs cut in Indiana to the volume of standing timber that was actually cut to produce these logs. In addition, the study revealed the size of walnut trees cut for products, their quality, and the volume coming from nongrowing-stock sources. Prior to this study, reliable converting factors for walnut timber cut in Indiana were not available. Those most commonly used in the past were developed mainly for broad species groups. Because less growing stock is usually cut per thousand board feet of logs produced for a high-value species like walnut, utilization factors for lower-value species will usually overestimate the walnut timber cut from growing stock.

With two exceptions, technical terms used throughout this paper are those used in Forest Survey and are defined in the Appendix. The exceptions are "growing stock" and "nongrowing stock." Growing stock, by Forest Survey definition, includes sawtimber and poletimber trees on nonforest land. In this paper such trees on nonforest land are classified as nongrowing stock. In most Forest Survey publications only the growing stock on commercial forest land is discussed.

Thus, growing-stock volume includes the saw-log portion (merchantable stem) and upper-stem portion of sawtimber trees on commercial forest land. Nongrowing-stock volume includes limbwood, cull trees and logs, and trees on nonforest land.

PROCEDURES

One hundred and forty walnut[1] trees were measured after felling and bucking at 19 logging operations in 1966. About half the trees were located in northeast and half in west central Indiana (fig. 1).

[1] *The volume of the 140 sample trees was 0.137 percent of the total walnut growing stock volume cut for products in Indiana in 1966. Past Forest Service studies in the North Central States have been considered adequate for calculating conversion factors if 0.01 percent of the volume cut was measured.*

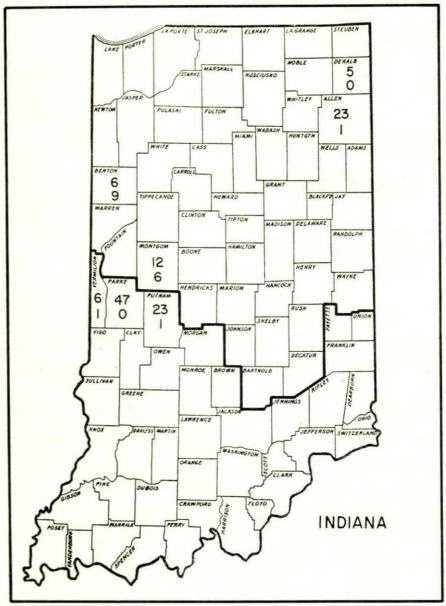

FIGURE 1. — Number of walnut trees measured by county. Top figure in each county indicates growing-stock trees, bottom figure nongrowing-stock trees.

Selection of Logging Operations and Sample Trees

Logging operations were found by talking to sawmill and veneer mill operators using walnut logs. Wherever possible, both single-product oriented and integrated logging operations were selected. No more than 10 walnut trees cut for veneer nor more than 10 trees cut for saw logs were measured at any single operation. Because few walnut trees were present on each logging operation, usually all of them were included in the sample.

Individual Tree Measurement

Each tree was classified as live-merchantable, cull, or dead. Tree origin was classed as commercial forest or nonforest land. The saw-log length and growing-stock length were measured. Then each log or bolt cut for a product was measured. Length was recorded to the nearest 1/10 foot and the top diameter inside bark to the nearest 1/10 inch. Each log was classified according to its use — veneer log or saw log. The gross and net board foot and cubic foot volumes (after cull deduction) were determined for each log, using table 4 (Appendix). As each log or bolt was measured, it was assigned to the proper tree class (live, dead, or cull). If logs or bolts were from dead or cull trees, their volumes were recorded as such. Logs or bolts from live trees, however, were next assigned to the proper land class (commercial forest land or nonforest land). Volumes of logs or bolts from nonforest land trees were recorded as such. If logs or bolts were from commercial forest land trees, however, their volumes were assigned to the proper tree-portion class (saw-log portion, upper stem, or limbwood). Every log was graded according to the system published in Report No. D1737-A of the Forest Products Laboratory, U.S.D.A. Forest Service.

Any growing stock that was cut and left in the woods as unmerchantable was considered logging residue. Each section of logging residue was measured and recorded for board foot and cubic foot volume (fig. 2).

FIGURE 2. — Unmerchantable growing stock was measured and the volume recorded as logging residue. (Photo courtesy of Dr. John C. Callahan, Purdue University)

Damage inflicted by the sample tree to surrounding trees during felling, bucking, and skidding was taken into account; volume of damaged trees was measured if they would die from their injury and remain unused. The net volume of damaged timber was recorded separately for cull trees, saplings, poletimber trees, and sawtimber trees.

RESULTS

Of the 140 walnut trees measured immediately after felling and bucking into products, 122 were growing-stock trees and 18 nongrowing-stock trees. All the trees cut were sawtimber-size (table 1); the smallest tree was 11.8 inches diameter at breast height (d.b.h.), and two-thirds of the growing-stock trees were 13.0 to 17.9 inches d.b.h. The nongrowing stock trees were larger on the average and included 2 culls and 16 trees from nonforest land.

Table 1. — Number of sample growing-stock and nongrowing-stock trees by diameter class

Diameter class (d.b.h. in inches)	Number of trees: Growing stock	Nongrowing stock
11.0-11.9	1	-
12.0-12.9	9	1
13.0-13.9	18	-
14.0-14.9	30	2
15.0-15.9	20	1
16.0-16.9	15	1
17.0-17.9	9	3
18.0-18.9	3	1
19.0-19.9	10	2
20.0-20.9	3	2
21.0-21.9	2	3
22.0-22.9	-	1
23.0-23.9	1	-
24.0-24.9	-	-
25.0-25.9	-	1
26.0-26.9	1	-
Total	122	18

Eighty-four percent of the volume in this sample of 140 harvested trees was growing stock. The standard error for growing stock was 3.5 percent. Uses of the trees by product classes were as follows:

Products cut from tree	Number of trees: Growing stock	Nongrowing stock
Saw logs only	61	13
Saw logs major,[1] veneer logs minor	35	2
Veneer logs only	1	1
Veneer logs major, saw logs minor	25	2
Total	122	18

[1] *A major product must contain more than 50 percent of the tree volume used for products; a minor product contains less.*

From the 140 sample trees, 279 saw logs and 84 veneer logs were cut. Most of the saw logs were 10 to 14 inches in small-end diameter inside bark (d.i.b.) and 8 to 13 feet long. Veneer logs were primarily 12 to 16 inches d.i.b., small end, and 6 to 14 feet long. According to this sample, few walnut veneer logs under 12 inches d.i.b. are used in Indiana, whereas saw logs are taken to a minimum of 7 inches d.i.b. The average veneer log and saw log contained 89 and 57 net board feet,[2] respectively.

Slightly over half of the saw-log volume came from Grade 3 logs, and about one-fourth from Grade 2 logs (fig. 3). As expected, nearly all the Grade 1 logs went to veneer mills. Two-thirds of all veneer-log volume came from Grade 1 and 2 logs. Logs below Grade 3 constituted 17 percent of the total log volume used for products.

Over 23,000 board feet of logs were produced from the sample trees; slightly more than two-thirds of this volume was saw logs and the rest was veneer logs (table 2). Of the 15,979 board feet of saw logs cut, 83.0 percent came from growing-stock volume on commercial forest land, 12.7 percent came from trees on nonforest land, and the remainder came from cull trees, cull logs, and

[2] *International ¼-inch log rule.*

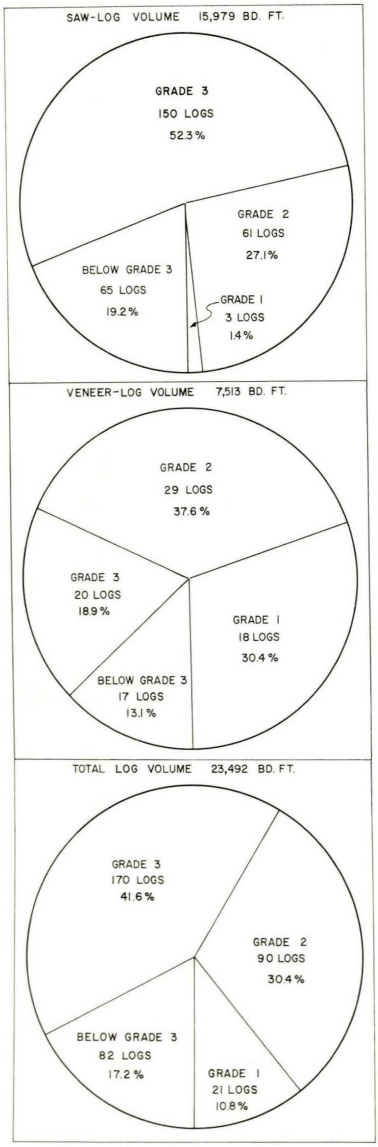

FIGURE 3. — Number of walnut saw logs and veneer logs and percent of volume by log grade, 140 sample trees, Indiana, 1966. Board-foot volumes are International ¼-inch log rule.

limbwood. As for the 7,513 board feet of veneer logs produced, 87.2 percent was growing-stock volume on commercial forest land — the remainder was from trees on nonforest land.

As shown in table 2, nearly one-sixth of the total saw-log and veneer-log volume came from nongrowing-stock sources — limbwood, cull trees and logs, and trees on nonforest land. Most of this nongrowing-stock log volume was cut from trees on nonforest land, a reflection of the high value of walnut products and the economic feasibility of removing one or a few walnut trees from a nonforest logging area. Because nonforest land is an important source of walnut logs in Indiana, resource analysts should include it when making growth and cut comparisons.

Logs cut from all sample trees contained 3,506 cubic feet, of which 2,965 cubic feet came from growing-stock trees. In spite of the high value of walnut products, 15 percent of the growing-stock volume was left in the woods as logging residue. About two-thirds of this residue came from the saw-log portion of the tree, and the remainder from the upper stem portion of sawtimber trees. Walnut logging should be carefully scrutinized for opportunities to utilize this significant amount of residue. The chance is only 1 in 20 that the actual percent of growing stock used for products is lower than 79 or higher than 92.

Based on the sample trees, 181.8 cubic feet of timber must be felled to provide 1,000 board feet of saw logs at a sawmill (table 3). This total consists of 153.1 cubic feet of saw logs and 28.7 cubic feet of logging residue. The saw-log volume comes from both growing stock (sawtimber) and nongrowing stock (cull trees and logs, limbwood, and trees on nonforest land) (fig. 4). On the average, each 1,000 board feet of saw logs contains 127.8 cubic feet of growing stock and 25.3 cubic feet of nongrowing stock. All the saw logs from growing stock come from the saw-log portion of sawtimber trees. The 25.3 cubic feet of nongrowing stock in each 1,000 board feet of saw logs contains 2.8 cubic feet of limbwood, 4.1 cubic feet from cull trees and logs, and 18.4 cubic feet from trees on nonforest land.

Table 2. — Volume of saw logs, veneer logs, and logging residue by source from 140 walnut trees, Indiana, 1966

BOARD FEET[1/]

Product	Growing stock [2/]		Non-growing stock [3/]				
	Sawtimber		Limb-wood	Sap-lings	Cull trees	Non-forest land	Total
	Saw-log portion	Upper stem					
Saw logs	13,261	-	306	-	379	2,033	15,979
Veneer logs	6,548	-	-	-	-	965	7,513
Total	19,809	-	306	-	379	2,998	23,492
CUBIC FEET							
Saw logs	2,041.7	-	45.7	-	66.1	293.6	2,447.1
Veneer logs	923.5	-	-	-	-	135.4	1,058.9
Total	2,965.2	-	45.7	-	66.1	429.0	3,506.0
CUBIC FEET							
Saw-log residue	264.0	125.4	-	9.9	58.5	-	457.8
Veneer-log residue	87.1	28.6	-	3.6	65.8	-	185.1
Total	351.1	154.0	-	13.5	124.3	-	642.9

1/ International 1/4-inch log rule.
2/ No products were cut from poletimber-size trees.
3/ No products were cut from dead trees.

Similarly, the logging residue resulting from harvesting saw logs comes from both growing stock and nongrowing stock. According to the sample, each 1,000 board feet of saw logs cut results in 24.4 cubic feet of logging residue from growing stock and 4.3 cubic feet from nongrowing stock. The 24.4 cubic feet of growing stock residue is from sawtimber trees — 16.5 cubic feet from the saw-log portion, and 7.9 cubic feet from the upper stem. The 4.3 cubic feet of nongrowing stock residue consists of 3.7 cubic feet of cull, and 0.6 cubic feet of saplings.

Overall, walnut veneer logs come from larger-diameter trees than saw logs. Because the larger trees have higher board-foot to cubic-foot ratios, only 165.6 cubic feet of walnut is cut to provide 1,000 board feet of veneer logs at the mill. In other words, the cubic-foot volume of walnut timber harvested to produce 1,000 board feet of veneer logs is, on the average, 9 percent less than the cubic-foot volume harvested to produce 1,000 board feet of saw logs. Of the 165.6 cubic feet of walnut timber required to provide 1,000 board feet of veneer logs, 24.7 cubic feet is logging residue.

Table 3. — Volume of Indiana walnut timber cut to provide 1,000 board feet[1] of saw logs or veneer logs at a primary wood-using plant, 1966

Source of timber cut	Saw logs		Veneer logs	
	Bd. ft.	Cu. ft.	Bd. ft.	Cu. ft.
Timber products output:				
From growing stock:				
Sawtimber trees:				
Saw log portion	830	127.8	872	122.9
Upper stem	0	0	0	0
Poletimber trees	0	0	0	0
Subtotal A	830	127.8	872	122.9
From nongrowing stock:				
Limbwood	19	2.8	0	0
Saplings	0	0	0	0
Cull trees and logs	24	4.1	0	0
Dead trees	0	0	0	0
Nonforest land	127	18.4	128	18.0
Subtotal B	170	25.3	128	18.0
Total timber products output (net volume of product received at processing plant)	1,000	153.1	1,000	140.9
Logging residue:				
From growing stock:				
Sawtimber trees:				
Saw log portion	94	16.5	64	11.6
Upper stem	--	7.9	--	3.8
Poletimber trees	0	0	0	0
Subtotal C	94	24.4	64	15.4
From nongrowing stock:				
Cull sections	--	3.7	--	8.8
Saplings	0	.6	0	.5
Subtotal D	--	4.3	--	9.3
Total logging residue	94	28.7	64	24.7
Total timber cut:				
From growing stock (Subtotals A + C)	924	152.2	936	138.3
From nongrowing stock (Subtotals B + D)	170	29.6	128	27.3
Total timber cut	1,094	181.8	1,064	165.6

1/ International 1/4-inch log rule

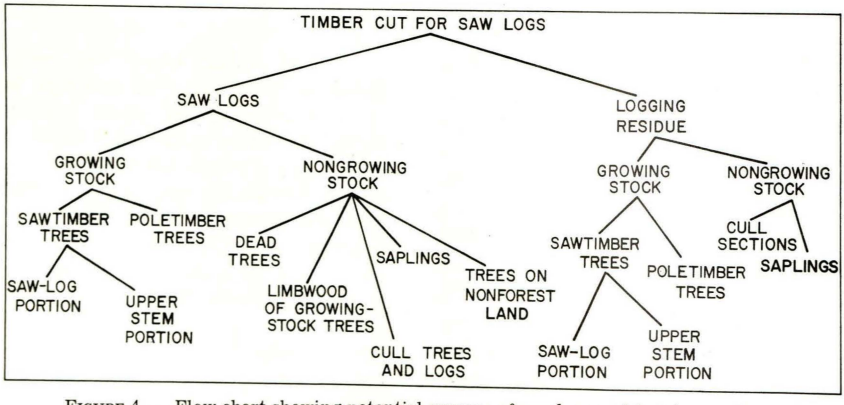

FIGURE 4. — Flow chart showing potential sources of saw logs and logging residue.

DISCUSSION AND CONCLUSIONS

The conversion factors — the principal result of this study — were used to determine the 1966 Indiana walnut timber harvest in the recent Indiana Forest Survey. If the volume[3] of walnut veneer logs and saw logs received at processing plants from Indiana forests is known, the factors in table 3 can be used to determine the amount and kinds of timber that were cut to provide these logs.

The conversion factors are easy to apply. For example, assume that 9 million board feet of saw logs and 6 million board feet of veneer logs were cut in Indiana in 1968. Then, using the appropriate factors in table 3, the following information can be obtained:

Total walnut cut from growing stock:

9,000 (924) + 6,000 (936) = 13,932,000 board feet

9,000 (152.2) + 6,000 (138.3) = 2,199,600 cubic feet

Total logging residue from growing stock:

9,000 (94) + 6,000 (64) = 1,230,000 board feet

9,000 (24.4) + 6,000 (15.4) = 312,000 cubic feet

Total walnut saw log volume from nonforest land:

9,000 (127) = 1,143,000 board feet

9,000 (18.4) = 165,600 cubic feet

Total volume of walnut cut from all sources:

9,000 (1,094) + 6,000 (1,064) = 16,230,000 board feet

9,000 (181.8) + 6,000 (165.6) = 2,629,800 cubic feet

Resource analysts, market analysts and industrial development groups may use these factors in estimating the present volume of Indiana walnut timber cut for saw logs and veneer logs, or in making short-range projections of the future Indiana walnut timber harvest. If net growth of walnut is also known or predicted, then growth and cut can be compared to determine whether the walnut resource is increasing or declining. Such comparisons are important in predicting the future of industries dependent upon walnut, in estimating future costs of walnut logs and stumpage, and in determining walnut log export policies.

[3] *International ¼-inch log rule.*

APPENDIX

Definitions

Commercial forest land. — Forest land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. Includes areas suitable for management to grow crops of industrial wood generally capable of producing in excess of 20 cubic feet per acre of annual growth.

Cull trees. — Live trees that do not contain at least one merchantable 12-foot saw log, now or prospectively, because of roughness, poor form, or rot.

Growing stock. — Sawtimber and poletimber trees on commercial forest land.

Growing-stock length. — Length to the last whole foot of the central stem of sawtimber and poletimber trees from ground level to a 4.0-inch diameter outside bark, or to a point where the central stem is terminated by branches, rot, or becomes unmerchantable before reaching the minimum diameter (4.0 inches).

Growing-stock volume. — Volume of sound wood in the bole of sawtimber and poletimber trees from stump to a minimum 4.0 inch top diameter outside bark, or to the point where the central stem breaks into limbs.

Limbwood. — That part of a poletimber or sawtimber tree that does not meet the requirements for growing stock portions of the tree, including all live, sound branches used for products.

Logging residue. — The unused portions of growing-stock trees cut for products.

Nonforest land. — Land that has never supported forests, and lands formerly forested where forest use is now precluded by development for nonforest uses, such as cropland, improved pasture, residential areas, and city parks. Also includes improved roads and adjoining rights-of-way, powerline clearings, and certain areas of water classified by the Bureau of Census as land. Unimproved roads, streams, canals, and nonforest strips in forest areas must be more than 120 feet wide, and clearings in forest areas must be more than 1 acre in size to qualify as nonforest land.

Nongrowing stock. — Cull trees, dead trees, cull sections of live growing-stock trees, limbs, and timber on nonforest land.

Poletimber trees. — Live trees of commercial species on commercial forest land at least 5.0 inches in diameter at breast height but smaller than sawtimber size, and of good form and vigor.

Saplings. — Live trees of commercial species 1.0 inch to 5.0 inches in diameter at breast height and of good form and vigor.

Saw-log portion. — Net volume of the bole of sawtimber trees from ground level to the point above which a saw log (according to Forest Survey definition) cannot be produced. The minimum saw-log top is 9.0 inches diameter outside bark for hardwoods. A saw log is defined by Forest Survey as a log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight and with a minimum diameter inside bark of 8 inches for hardwoods.

Sawtimber trees. — Live trees of commercial species on commercial forest land containing at least a 12-foot saw log. Hardwoods must be at least 11.0 inches in diameter at breast height.

Timber cut. — Volume of timber products cut from live sawtimber and poletimber trees plus the logging residue that results from harvesting and transporting products from commercial forest lands.

Upper stem. — That part of the bole of sawtimber trees above the merchantable sawtimber top to a minimum top diameter of 4.0 inches outside bark or to a point where the central stem breaks into limbs.

Table 4. — Gross volume[1] of bolts and logs of different sizes

Top d.i.b. of piece, in inches	Length of bolt or log in feet															
	2		4		6		8		10		12		14		16	
	Bd.ft.	Cu.ft.	Bd.ft.	Cu.ft.	Bd.ft.	Cu.ft.	Bd.ft.	Cu.ft.	Bd.ft.	Cu.ft.	Bd.ft.	Cu.ft.	Bd.ft.	Cu.ft.	Bd.ft.	Cu.ft.
4	-	0.2	-	0.4	-	0.5	-	0.7	-	0.9	-	1	-	1	-	1
5	-	.3	-	.6	-	.8	-	1	-	1	-	2	-	2	-	2
6	3	.4	5	1	7	1	10	2	10	2	15	3	15	4	20	4
7	3	.6	5	1	10	2	10	2	15	3	20	4	25	5	30	6
8	5	.7	10	1	10	2	15	3	20	4	25	5	35	6	40	7
9	5	1	10	2	15	3	20	4	30	5	35	6	45	8	50	9
10	5	1	15	2	20	3	30	5	35	6	45	8	55	9	65	11
11	10	1	20	3	25	4	35	6	45	7	55	9	70	11	80	13
12	10	2	25	3	35	5	45	7	55	9	70	11	85	13	95	15
13	15	2	25	4	40	6	55	8	70	10	85	12	100	15	115	17
14	15	2	30	4	50	7	65	9	80	12	100	14	115	17	135	20
15	20	3	35	5	55	7	75	10	95	13	115	16	135	19	160	22
16	20	3	40	6	65	9	85	12	110	15	130	18	155	22	180	25
17	25	3	50	7	70	10	95	13	125	17	150	21	180	24	205	28
18	25	4	55	7	80	11	110	15	140	19	170	23	200	27	230	32
19	30	4	60	8	95	12	125	17	155	21	190	26	225	30	260	35
20	35	4	65	9	100	14	135	18	175	23	210	28	250	33	290	39
21	40	5	75	10	115	15	155	20	195	26	235	31	280	37	320	42
22	45	5	85	11	130	16	170	22	215	28	260	34	305	40	355	46
23	45	6	90	12	140	18	185	24	235	30	285	37	335	44	390	50
24	50	6	100	13	155	19	205	26	255	33	310	40	370	47	425	55
25	55	7	110	14	165	21	220	28	280	36	340	43	400	51	460	59
26	60	7	120	15	180	23	240	31	305	39	370	47	435	55	500	64
27	65	8	130	16	195	25	260	33	330	42	400	50	470	59	540	69
28	70	9	140	18	210	27	280	35	355	45	430	54	510	64	585	73
29	75	9	150	19	230	29	305	38	385	48	465	58	545	68	630	79
30	80	10	160	21	245	31	325	41	410	51	495	62	585	73	675	84
31	90	10	170	22	260	33	350	43	440	55	530	66	625	78	720	89
32	95	11	185	23	280	35	375	46	470	58	570	70	670	83	770	95
33	100	12	200	24	300	37	400	49	500	62	605	75	715	88	820	100
34	105	13	210	26	320	39	425	52	535	65	645	79	760	93	875	107
35	110	14	220	28	340	41	450	55	565	69	685	84	805	98	925	113
36	120	14	235	29	355	43	475	58	600	73	725	88	855	104	980	120
37	130	15	250	30	380	46	505	61	635	77	770	93	905	110	1,040	126
38	135	16	265	32	400	48	535	65	670	81	810	98	955	115	1,095	133
39	140	17	280	34	420	51	565	68	710	86	855	103	1,005	121	1,155	140
40	150	18	300	36	445	54	595	72	750	90	900	109	1,060	128	1,220	147

1/ Cubic feet--peeled wood; board feet--International 1/4-inch rule.

ABOUT THE FOREST SERVICE . . .

As our Nation grows, people expect and need more from their forests — more wood; more water, fish, and wildlife; more recreation and natural beauty; more special forest products and forage. The Forest Service of the U.S. Department of Agriculture helps to fulfill these expectations and needs through three major activities:

- Conducting forest and range research at over 75 locations ranging from Puerto Rico to Alaska to Hawaii.
- Participating with all State forestry agencies in cooperative programs to protect, improve, and wisely use our Country's 395 million acres of State, local, and private forest lands.
- Managing and protecting the 187-million acre National Forest System.

The Forest Service does this by encouraging use of the new knowledge that research scientists develop; by setting an example in managing, under sustained yield, the National Forests and Grasslands for multiple use purposes; and by cooperating with all States and with private citizens in their efforts to achieve better management, protection, and use of forest resources.

Traditionally, Forest Service people have been active members of the communities and towns in which they live and work. They strive to secure for all, continuous benefits from the Country's forest resources.

For more than 60 years, the Forest Service has been serving the Nation as a leading natural resource conservation agency.